PAGE Conference 2023

Wednesday, May 24, 2023
Life Sciences Building, York University

PAGE
PHYSICS AND ASTRONOMY GRADUATE EXECUTIVE

Schedule

9:00AM – 9:45AM	**Registration and Breakfast:** Pastries and Refreshments	Main Lobby
9:45AM – 10:00AM	**Opening Remarks** Akash Chauhan, PAGE President	LSB 106
Invited Talk I 10:00AM – 10:30AM	**Prof. Joel Zylberberg** Unexpected event signals in the apical dendrites of cortical pyramidal neurons	LSB 106
Student Session I	**Chair:** Coral Hillel, PAGE Executive	Main Lobby LSB 106
10:30AM – 10:35AM	**Udhay Dogra** An Introduction to the effects of Dark Matter Cores on Gravitational Waves	
10:35AM – 10:45 AM	**Justin Kerr** Searching for Magnetic Monopoles with the ATLAS Detector	
10:45AM – 10:55AM	**Grace Bischof** Effect of Spectral Type on a Correlated-K Climate Model	
10:55AM – 11:05AM	**Antoine Bourget** Optical Polarization studies of suspended beads in aqueous solution: An analog for radar scattering in icy regoliths	
11:05AM – 11:20AM	**Coffee Break**	
11:20AM – 11:25AM	**Mark Vertlib** Simulating Low-Gravity Exoplanet Life Detection False Positives	
11:25AM – 11:35AM	**Coral Hillel** Investigating Isomerization Kinetics of Bioinspired Azobenzene Photoswitches as a Novel Optical Sensor for Oxygen	
11:35AM – 11:45AM	**Rohith Kaiyum** Fabrication and characterization of a fiber optic radiochromic dosimeter probe	
11:45AM – 11:55AM	**Shany Mary Oommen** Measurement of thickness dependent anisotropic thermal conductivities in highly anisotropic semiconductors	
12:00PM – 12:50PM	**Lunch:** Roman Pizza and Salad (Fortinos)	Main Lobby LSB 106
Keynote Address 12:50PM – 2:00PM	**Prof. Mark Andrews** *(McGill University)* Living Emergent Light	LSB 106
Invited Talk II 2:00PM – 2:30PM	**Prof. Anantharaman Kumarakrishnan**	LSB 106

	Laser based Measurements of Diffusion using Video Microscopy and Optical Lattices—from Microparticles to Atoms	
2:30PM – 2:45PM	**Coffee Break**	Main Lobby LSB 106
Student Session II	**Chair:** Coral Hillel, PAGE Executive	LSB 106
2:45PM – 2:55PM	**Olga Andriyevska** Novel Transcranial Magnetic Stimulation Coil Design Introduces an In Situ Detector and Adjustability	
2:55PM – 3:05PM	**Anirudh Krishnadas** Assessing melting like transition in different cluster types	
3:05PM – 3:15PM	**Eduardo Chomen Ramos** Characterization of microparticles in free space and liquid cultures using optical tweezers	
3:15PM – 3:25PM	**Olha Fedoryk** Cellural communication. Modeling collective dynamics of the inner ear	
3:25PM – 3:30PM	**Filipe Ledo** Synchronization between Binaural SOAEs Measurements	
3:30PM – 3:40PM	**Jaskaran Randhawa** Development of a Modulation-Free Laser Frequency Stabilization Setup for Atomic Lifetime Measurements	
Invited Talk III 3:45PM – 4:15PM	**Prof. Sylvie Morin** Properties and Surface Chemistry of Nanostructured Electrode Materials	LSB 106
4:15PM – 4:30PM	**Closing Remarks and Winners** Akash Chauhan, PAGE President	LSB 106

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Abstracts: Keynote Speaker

Living Emergent Light

Professor Mark Andrews
Department of Chemistry, McGill University

This talk covers a broad sampling of the ways that nanoscale materials are self-assembled and self-organized by biology, biomimicry and artificial means to orchestrate various kinds of patterns and optical responses. We begin with a brief explanation of the title through a demonstration of "emergence" in ferrofluids whose magnetic field driven pattern formation is a symmetry-breaking process that can be encoded by kinetic trapping. We then proceed to optical responses based on phase transitions of rod-like chitin and cellulose nanocrystals, leading to various types of diffraction gratings, including photonic crystal-like behavior, optical non-reciprocity and a brief example of the use of bio-based cellulose nanocrystals for encryption. This is followed by some examples of optical-self-inscription of waveguide and wrinkle patterns in hybrid silica glasses. From these glasses we make a link back to biology: biogenic silica for passive integrated optics is discussed in the context of how the ornate nanoscale patterns of the frustules (exoskeletons) of phytoplankton allow benthic *Nitzschia filiformis* to increase photo conversion efficiency for photosynthesis under diminished light conditions. An equivalent circuit model arises that gives a convenient way to understand how the disordered photonic crystal framework of the frustule deals with variable light conditions.

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Abstracts: Invited Speakers

Unexpected event signals in the apical dendrites of cortical pyramidal neurons

Professor Joel Zylberberg
Department of Physics & Astronomy, York University

Scientists have long conjectured that the brain's cortex learns the structure of the environment in a predictive, hierarchical manner. According to this conjecture, expected, predictable features are differentiated from unexpected ones by comparing bottom-up and top-down streams of information. It is theorized that the cortex then changes the representation of incoming stimuli, guided by differences in the responses to expected and unexpected events. To test these ideas, we compared neural activity recorded at the somata and distal apical dendrites of cortical pyramidal cells: these neuronal compartments tend to receive bottom-up and top-down information, respectively. Leveraged recent improvements in *in vivo* microscopy, and in image processing, we were able to track the responses of individual somata and apical dendritic branches of layer 2/3 and layer 5 pyramidal neurons over multiple days in awake, behaving mice using two-photon calcium imaging, while the mice were exposed to stimuli that were initially unexpected. Our main finding was that both somata and distal apical dendrites of cortical pyramidal neurons exhibit distinct unexpected event signals that systematically change over days, as the animals learn about these stimuli. Interestingly, these top-down vs bottom-up responses evolved in opposite directions in the somata and distal apical dendrites as a result of learning, supporting the hierarchical predictive coding model of sensory cognition.

Laser based Measurements of Diffusion using Video Microscopy and Optical Lattices—from Microparticles to Atoms

Professor Anantharaman Kumarakrishnan
Department of Physics & Astronomy, York University

We describe simple video microscopic techniques for measuring the diffusive motion of microparticles trapped in optical tweezers and determining the particle mass. We also use laser forces to create optical lattices of alkali atoms and probe their diffusive motion using a coherent transient technique. Based on this experiment, we report the most accurate determination of diffusion coefficients for rubidium atoms in buffer gas environments.

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Abstracts: Invited Speakers

Properties and Surface Chemistry of Nanostructured Electrode Materials

Professor Sylvie Morin
Department of Chemistry, York University

Climate change and the need for alternative energy sources can be addressed through the use of electrochemical technology, like water splitting to obtain hydrogen gas. Hydrogen is viewed as one of the energy carriers of the future. It is environmentally friendly, when produced sustainably, inexhaustible and possesses high energy density. At present, hydrogen is mainly produced from steam methane reforming and coal gasification.

Water splitting involves two half-reactions, hydrogen evolution reaction and oxygen evolution reaction (OER). The OER is kinetically slow (see proposed mechanism in Fig. 1) and hence associated with a high overpotential. Transition metals spinel oxides of the type $M_xCo_{3-x}O_4$ (where M = Ni, Cu, Mn, Zn, Fe) are good candidates for O_2 production due to their excellent catalytic properties, controllable composition, structure and morphology. However, in the literature their performance is inconsistent. To understand their behaviour we systematically investigated series spinel oxides. Detailed characterization allows us to establish the structure, composition and oxidation state of the metal ions at the surface of these materials in relation to their electrocatalytic properties. Our result will show the importance of detailed surface and electrochemical characterization when reporting catalyst performances.

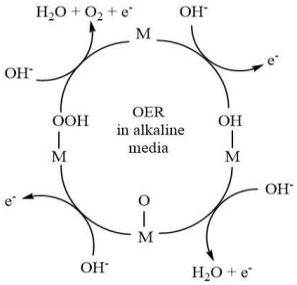

Figure 1 OER scheme in alkaline media showing the four-electron transfer steps.